Case Study 82

Consumer connection to Community Heating in Sheffield

- Low capital cost alternative to boilerplant
- Non-disruptive installation
- Reliable and economical operation
- Reduced maintenance costs
- Substantial reductions in fossil fuel CO_2 emissions

Introduction

This Good Practice Case Study is one of two which look at the expanding city-wide Community Heating system that is owned and operated by Sheffield Heat and Power Ltd (SHP). SHP has been operating since 1988 and has already demonstrated that Community Heating systems can be, both technically and economically, successful.

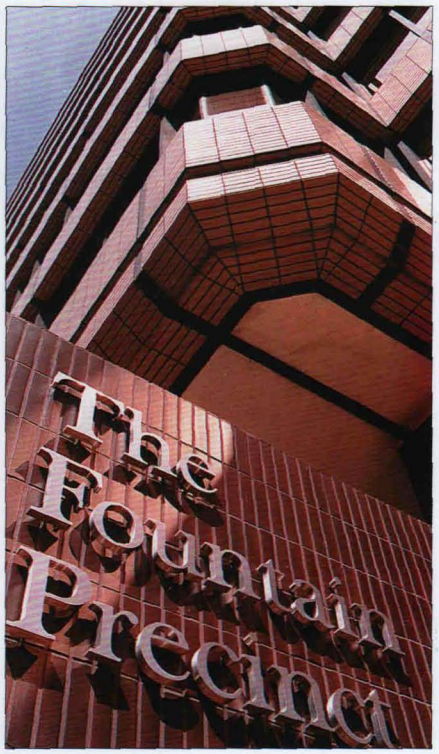
EEO Good Practice Case Study 81 provides an introduction to the many facets of SHP's operations, and should be of interest to anyone considering establishing, or connecting to a Community Heating scheme.

This Case Study takes a more detailed look at the experiences of three SHP customers.

Sheffield City Council - Markets Department

Sheffield City Council's Markets Department owns and administers a number of market premises within the city. Castle Market is the largest. This comprises two major retail trading floors (which house 239 market stalls), 33 permanent shop units and 3700 m^2 of office space, all of which are contained within a five-storey block built in 1959.

Heating and hot water services are provided, from 08 00 to 18 00, six days per week, via a central, ground floor boilerhouse. There is a particularly high demand for hot water on Tuesday, Friday and Saturday afternoons, which are the traditional days for the meat and fish market.



The Fountain Precinct served by Community Heating

Sheffield City Council's Markets Department is responsible for all operating and maintenance costs associated with the central boilerhouse. Good records have been kept to ensure that operating Community Heating charges can be recovered via stall rentals, etc.

Plant Details

Castle Market became a SHP customer in March 1990. Prior to that, space heating was provided by an array of 24 modular atmospheric gas boilers with a total installed load of 1800 kW. Centralised domestic hot water production was provided by two gas-fired water heaters linked to two 1800 litre storage vessels.

What is Community Heating?

Community Heating involves the use of large centralised boilerplant (or other heat sources) to heat a number of discrete, remote premises. Heat (usually in the form of hot water) is distributed from the central boilerpoint to the Community Heating system's customers via well insulated underground pipes.

Community Heating systems can range in size from those linking two or three buildings, through to networks which serve entire cities. By utilising central boilerplants, Community Heating systems can benefit from competitive fuel purchasing and can utilise alternative energy sources such as bio-fuels or Combined Heat and Power.

Combined Heat and Power

Combined Heat and Power (CHP) is the production of electricity and useful heat from a single plant.

When electricity is generated only a small part of the input energy is converted to electricity (typically 30-50%). The remainder of the energy consumed by the generation process is dissipated via the cooling systems as waste heat. If a suitable use for this waste heat can be found, it can be usefully recovered.

Community Heating systems are ideally suited to use the waste heat from CHP power stations, to heat nearby buildings.

The existing gas-fired plant provided adequate space heating via two separately optimised heating circuits (one serving the offices, the other serving the main market areas). However, the domestic hot water provision always proved to be inadequate, particularly at times of very high demand. In an attempt to overcome this, modifications were undertaken whereby three of the

"Community Heating ... reliable and economically competitive"

BEST PRACTICE PROGRAMME

ENERGY EFFICIENCY
DEPARTMENT OF THE ENVIRONMENT

SHEFFIELD CITY COUNCIL MARKETS DEPARTMENT

Stalls at Castle Market

Period	Energy purchased* (MWh)	Net energy delivered* (MWh)	Energy cost (£)	Net heat cost (p/kWh)	Operating & maintenance (O&M) cost (£)	Total running cost (£)
Dec 1988 to Nov 1989 (gas boilers)	2707	1895	28 870	1.52	15 000	43 870
Dec 1992 to Nov 1993 (Community Heating)	2001	2001	38 481	1.92	negligible	38 481

**When using conventional gas or oil fired boilerplant only approximately 70% of the energy content of the purchased fuel is actually used to heat the building (the 'net' heat requirement). The remainder of the fuel's energy content is lost in the hot flue gases produced by the boilers. 'Purchased' energy, always therefore exceeds the building's 'net' heat requirement.*

In contrast, virtually no heat is lost from a Community Heating system's heat exchanger and hence the purchased heat almost exactly equals the building's net heat requirement.

Table 1 Castle Market annual energy data

heating boiler modules were connected to the hot water storage vessels, to provide additional recovery capacity. Although this measure helped somewhat, shortages of hot water were still being experienced at times of high demand.

The domestic hot water supply problem was of major concern to the Markets Department, because:

- hygiene standards were being prejudiced within the market area
- substantial manpower time was being expended in making sure that the maximum quantity of hot water was being produced at all times and in dealing with the numerous complaints which were being received from the Market's tenants.

Given these problems and the age of the boilers, major refurbishments had already been planned for 1990. Budget estimates at that time had identified a need for investment of up to £60 000 in order to replace the boilerplant and upgrade the domestic hot water provision.

In late 1989, however, consideration was given to connection to the SHP Community Heating system. Design studies were undertaken by SHP and the City Council's Design and Building Services (DBS) Department. It was determined that the best configuration for Castle Market would be a 1700 kW heating plate heat exchanger supported by a 600 kW domestic hot water plate heat exchanger.

These were subsequently supplied and installed by SHP at a cost of £28 773 with a further Community Heating charge of £6600 being levied for connection to the Community Heating system. Capital cost savings of between approximately £15 000 to £25 000 were therefore immediately made by the City Council Markets Department as a result of connecting to the Community Heating system rather than replacing the existing boilerplant.

Furthermore, SHP agreed to spread the installation cost over the 10 year heat supply contract period, significantly reducing the Market Department's capital requirement.

Operating Experiences and Costs

The installation was undertaken quickly and efficiently, the plate heat exchangers being installed in parallel with the existing boilerplant and the final changeover to Community Heating being undertaken within a single day.

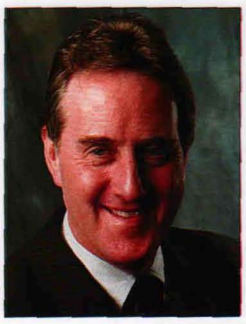
Since installation, the Markets Department has found that space heating within the five-storey office block has suffered no detrimental effect and all problems with lack of domestic hot water supply to the market areas have been totally cured.

The SHP installation has proved to be reliable and there have been no breakdowns or interruptions to the heat supply. Furthermore, the maintenance costs are 'negligible' (see table 1). The Markets Department calculates that annual maintenance and operating labour cost savings of approximately £15 000 per annum have been obtained (relative to the extraordinary manpower requirements that were required to nurse the previous, inadequate system).

Since the change to Community Heating, net heat requirements have increased slightly at the Castle Market due to the larger quantities of hot water that are now produced. Whilst energy costs have also increased, these are more than offset by reduced operating and maintenance costs.

In addition, removal of the existing boilers will ultimately liberate approximately 70 m^2 of usable space in the boilerhouse, for which the Markets Department has already identified a specific use. The Markets Department estimates that the cash value of this additional usable space will be approximately £10 000 per annum (in 'new build' situations the value of space saved can be even greater).

Overall, the Markets Department believes that the costs of owning and operating the Community Heating system are broadly similar to those associated with gas-fired boilerplant, and has no doubt that its reliability and the ability to provide ample quantities of domestic hot water on demand make it the correct choice for this application. Furthermore, the change to Community Heating has had major environmental benefits, with savings of over 500 tonnes/year of CO_2 emissions at Castle Market alone.



'Thanks to the Community Heating system we now have ample hot water supplies at all times'
– Mr. Jack Christopher, Director of Markets

The Fountain Precinct – Slough Estates

Introduction

Slough Estates, a national property investment and development company, owns and manages the prestigious Fountain Precinct office complex in Sheffield. This development comprises three wings, two wings being of six storeys and one of nine storeys, grouped around a public piazza. It has a total net area of approximately 11 612 m^2 and was built in 1976.

The development has a very high profile and office tenants include KPMG Peat Marwick, Siemens Nixdorf, Commercial Union Assurance, Equitable Life Assurance, Legal & General Assurance and Iveco Ford Truck Ltd. In addition to office accommodation, the development also houses a night-club (which operates until 02 00 each morning) on the ground floor and a public house in the basement.

Operating and maintenance costs associated with providing heating and hot water to the development are paid by Slough Estates, but are ultimately recovered from their tenants via a service charge.

Plant Details

Originally, The Fountain Precinct was heated by two, 880 kW gas-fired low temperature hot water boilers, located in a rooftop plantroom. Domestic hot water was provided via point-of-use electric heaters.

In 1991, however, it was clear that the existing boilerplant was nearing the end of its useful life, so plans were made to replace it. The opportunity for connecting to the SHP Community Heating system arose and an economic assessment was undertaken by Slough Estates. It was concluded that use of the Community Heating system provided an economic alternative to new gas boilers, and the environmental benefits that accrued from the use of recovered waste heat were particularly attractive to Slough Estates' Utilities Division. The decision was therefore made to link up with the SHP Community Heating network.

Two plate heat exchangers were installed (combined capacity 1.8 MW) one exchanger being dedicated to the office block, the other exchanger serving the night-club and pub. In contrast to the boilerplant, the plate heat exchangers were installed at basement level on a platform within the underground car park. This location reduced installation costs, resulted in no useful space being taken up (it is still possible to park a car under the heat exchanger installation) and allowed the heating system efficiency within the building to be dramatically improved. (It was now possible to heat the nightclub 'out of hours' without having to pump hot water up and down the substantial rising mains to and from the rooftop boilerhouse.)

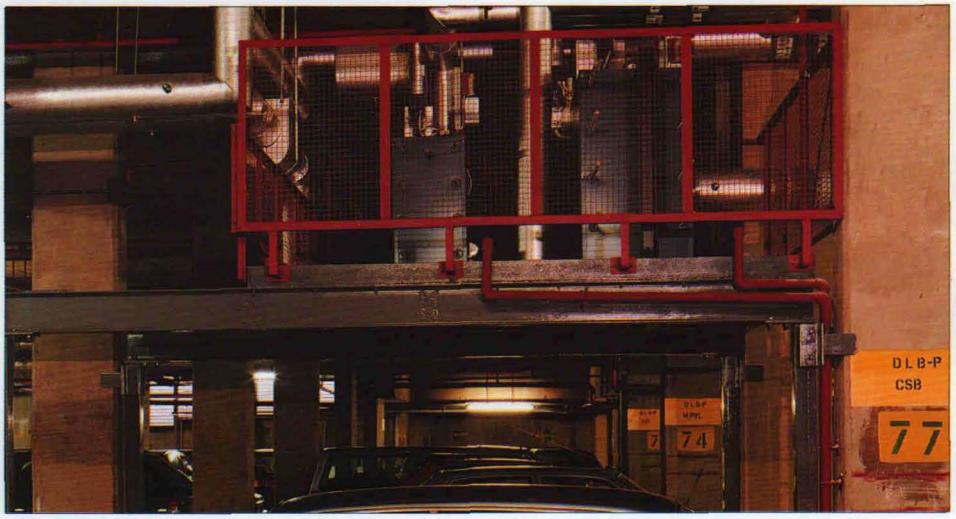


Plate heat exchanger situated in the underground car park at The Fountain Precinct

The heat exchanger design and installation was undertaken by SHP, whilst Slough Estates undertook its own pipework modifications (including new pumps) and built the support platform.

The installation was completed without disruption to the site's activities, other than limited restrictions at times within the car park.

As a precaution, Slough Estates decided to retain its existing boilers as a back-up heating facility. The minimum necessary repairs were therefore undertaken rather than total replacement as had originally been proposed. The retained boilers are operated for approximately one week per year in order to maintain their operability. They have never, however, been called upon to operate due to failure of the SHP system.

Operating Experiences and Costs

Since connecting to SHP the quantity of energy purchased by The Fountain Precinct has reduced dramatically (see table 2). Even allowing for a 70% annual boilerhouse efficiency, the net heat requirements of the building have reduced by approximately 500 MWh per annum (equivalent to nearly 30% of historical requirements). The purchased gas (heat) cost has also dropped by approximately £5000/year.

These savings have resulted from the dramatic improvements in efficiency that have been obtained by the provision of a second plate heat exchanger to serve the night-club and bar, in line with their different operating hour requirements.

While it is possible that some of these efficiency improvements could have been obtained by re-engineering a gas-fired system, it must also be recognised that the unique characteristics of the plate heat exchanger installation, ie no requirement for flue or ventilation air, means that such an energy efficient installation could not have been practically achieved at The Fountain Precinct using a natural gas-fired boiler.

Slough Estates decided to keep their existing boilerplant as a back-up facility. They acknowledge that this decision has reduced the savings in maintenance and labour costs which could have accrued as a result of connection to the Community Heating scheme.

Slough Estates is pleased with its decision to convert to Community Heating given the very real energy cost and consumption savings that have been made, and the environmental benefits that have accrued. Since converting to Community Heating, carbon dioxide emissions at The Fountain Precinct have dropped by over 650 tonnes/ year.

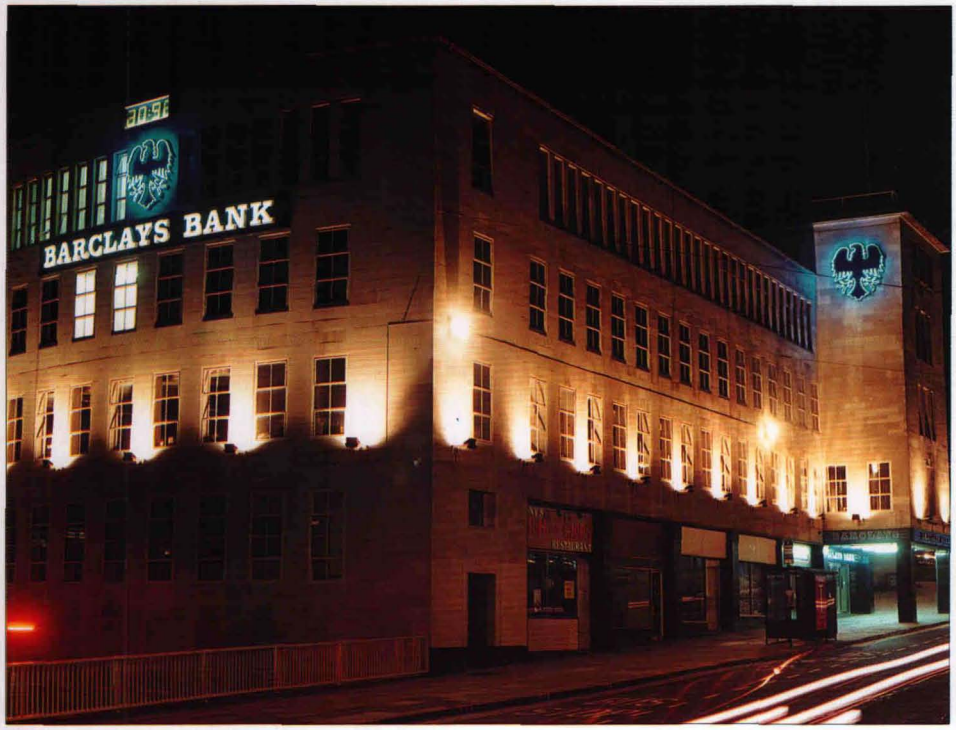
Period	Energy purchased* (MWh)	Net energy delivered* (MWh)	Energy cost (£)	Net heat cost (p/kWh)	Operating & maintenance (O&M) cost (£)	Total running cost (£)
Jan to Dec 1990 (gas boilers)	3202	2241	37 799	1.69	500	38 299
Jan to Dec 1993 (Community Heating)	1740	1740	32 501	1.87	500	33 001

*For definition see table 1.

Table 2 The Fountain Precinct annual energy data

'Connection to the Community Heating network has led to reduced energy consumption and costs at The Fountain Precinct, as well as providing environmental benefits for us all' – *Miss Tina Nicholls, Building Manager, Slough Estates plc*

BARCLAYS BANK



Barclays Bank – satisfied customer of SHP

Barclays Bank

The main branch Barclays Bank building in Sheffield was built in 1967 and houses the main district branch and corporate business centre. The floor area is approximately 4500 m^2. The building is occupied typically from 08 30 to 17 30 Monday to Friday.

Plant Details

Heating and hot water to the building was historically provided by three oil-fired boilers located within a basement plantroom. The domestic hot water facilities included the provision of two storage calorifiers.

These services had in the past proved to be adequate, however by 1990 it was clear that the boilerplant was in need of urgent replacement along with its flue and ancillary equipment. A feasibility study was therefore undertaken by Barclays Bank Property Holdings Ltd to consider the alternatives of the installation of gas-fired boilerplant against connection to the SHP community heating network. It was concluded that although the capital cost of installing the SHP system would be less than that of gas boilers, it was predicted that the annual fuel costs would be somewhat higher.

When other operating costs (for example maintenance) were taken into account, along with financing charges, etc it was concluded that the economic case was very finely balanced between a natural gas plant and the Community Heating network. Given that the two options were economically comparable there was policy support from higher management within Barclays Bank for the adoption of the environmental advantage of connection to the Community Heating system.

With the decision to move to Community Heating, one of the heating boilers was removed to make way for an 800 kW heating plated exchanger and a 100 kW domestic hot water plate heat exchanger. The two domestic hot water calorifiers were removed.

At the time, it was decided to retain the remaining heating boiler and the domestic hot water boiler as emergency back-up. After two years operating experience, Barclays Bank was satisfied that the SHP system was reliable. As a consequence the boilers and oil tanks were removed.

A new energy management system has recently been installed within the building and this has been successfully interfaced with the SHP heat exchanger systems.

Sheffield Heat and Power undertook the full design and installation of the plate heat exchanger. It included the installation of upgraded heating pumps to counteract the increased pressure drop.

Operating Experiences

Barclays Bank has been impressed with the service provided by SHP, both during the installation phase and subsequent operations. Energy consumption within the building has remained virtually unchanged since the change to Community Heating although the purchased fuel and energy costs have increased slightly as had been expected. However, overall operating costs remain competitive with gas-fired plant as predicted.

At Barclays Bank the SHP installation has proved reliable both in terms of providing the required level of building service along with security of supply.

The bank has a number of tenants (who occupy neighbouring ground floor shops). It has now installed heat sub-meters (linked to its new building energy management system) and will be using these for direct billing of tenants.

The bank is pleased that it made the decision to link to the SHP network, given that demonstrable environmental benefits have accrued with little or no financial penalty.

Conclusions

Converting to a Community Heating network is a quick and non-disruptive process. The Community Heating system's plate heat exchanger requires only one-tenth the space of equivalent boilerplant, liberating potentially valuable floor area (particularly if incorporated into new buildings at the design stage). The plate heat exchanger is silent, requires no flue, ventilation air or fire protection and hence can be located in places unsuitable for boilerplant.

Capital installation costs associated with connection to a Community Heating system are significantly less than those required for conventional boilerplant. Community Heating provides a reliable, cost-effective and environmentally friendly alternative to other heating methods.

'Community Heating has shown itself to be a reliable and economically competitive alternative to conventional gas fired boilerplant at Barclays Bank'
– Mr. Dave Sheldon, Regional Engineer Barclays Property Holdings Ltd

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